Chapter 5

Antifeedant activity of *Lantana camara* L. crude extract on moth pests

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ABSTRACT:- *Lantana camara* L. (Lamiales: Verbenaceae) is the most cultivated species of the genus *Lantana* with > 650 varieties grown worldwide. It has potent antifeedant properties due to its phytochemical composition containing essential oils, phenolics, saponins, terpenes, and many more. Moth pest infestation has become very devastating due to the development of resistance towards insecticides. So botanicals such as *Lantana camara* are very effective in controlling insect populations without harming their distribution and abundance in the ecosystem. Botanicals serve dual problems of chemical pesticides i.e., pest resistance and bio-magnification of these pesticides in successive tropic levels because after doing their potent work degrade easily. Moths such as *Spodoptera, Helicoverpa,* etc. cause mass-scale destruction of crops leading to huge losses to farmers, so experiments are going on for effective biological control methods. Antifeedant activities provide a way to protect plants

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by deterrent feeding property and partially affecting their life cycle. This method is very potent in maintaining pest population below the injury threshold so that moth's diversity can be maintained and crops are protected.

Keywords: *Lantana camara* L., Antifeedent, Phytochemical, Phenolic, Saponin, Terpene, Pest-resistance, Botanicals

INTRODUCTION

The word antifeedant is defined as any substance either chemical or biological in origin that promotes deterrent feeding properties among insect larvae. The larval stage is the most feeding stage causing damage to the host plant. According to the review study on Insect Antifeedant[1], using insect antifeedants as crop protectants is intuitively attractive. Pest management in agriculture, forestry, and managed landscapes has often relied on toxic, broad-spectrum insecticides with negative impacts on natural enemies, pollinators, and other non-target organisms. Additionally, persistent use of particular insecticides frequently causes the pests intended for population control to develop resistance. In nature, insect-plant chemical interactions are typically quite modest. Instead of directly killing insects, most plant defensive compounds prevent insect herbivory by preventing eating, oviposition, or larval growth. The identification of potential deterrent compounds that may be isolated in large enough amounts or synthesized for use as crop protectants is one use of our understanding of plant defense chemistry.

WHAT EXACTLY IS AN INSECT ANTIFEEDANT?

Some authors claim that any compound that hinders an insect's ability to consume food (feed) is an antifeedant. I favor a more limited definition, such as a behavior-modifying chemical that prevents feeding by exerting a direct impact on an insect's peripheral sensilla (also known as taste organs)[2]. This definition does not include substances with sub-lethal toxicity to insects or substances that act on the insect's central nervous system to restrict eating (after ingestion and absorption). Briefly, an antifeedant is something that tastes unpleasant to insects. Antifeedant activity is typically shown in laboratory bioassays that involve either choice or non-choice tests carried out for a brief period. Since reduced eating in a long-term test could readily result from post-ingestive toxicity or malaise in the exposed insects, rather than a behavioral basis, bioassays that claim to reveal antifeedant effects but prolong beyond 4-6 hours should be considered with caution. Nowadays, antifeedant action is highly helpful in preserving crops from widespread devastation while also minimizing environmental impact. Numerous botanicals have strong antifeedant properties, and when employed in different compositions, they can be quite effective at controlling insect pests. Some of them are listed in the table below -

Table 1: Shows antifeedants and their source.

Antifeedant	Chemical class	Source
Azadirachtin	Limonoid	*Azadirachta indica*
Nicotine	Alkaloid	*Nicotiana tobacum*
Lantana oil	Sesquiterpenes	*Lantana camara*
Caffeine	Alkaloid	*Coffea arabica*
Cocaine	Alkaloid	*Erythroxylum coca*
Tannic acid	Tannin	*Medicago sativa*
Morphine	Opioid	*Papaver somniferum*

Lantana camara L. (Lamiales: Verbenaceae) is the most cultivated species of the genus *Lantana* with > 650 varieties grown worldwide in many different forms and a multitude of colours. It is a fast-growing, low-maintenance plant with wide ecological tolerance. It can be an invasive and poisonous weed in tropical and subtropical environments but also has many positive attributes such as enriching soil, retaining humus, slowing soil erosion, etc.[3].

Veraplakorn (2018)[4] detailed the taxonomical classification of *Lantana camara* as – Kingdom – Plantae; Sub-kingdom-Tracheobionta; Super-division-Spermatophyta; Division-Magnoliopsida; Subclass-Asteridae; Order-Lamiales; Family-Verbenaceae; Genus-*Lantana*; Species- *camara*

A flowering ornamental plant called *Lantana camara* Linn. is sometimes referred to as Lantana, Wild Sage, Surinam Tea Plant, Spanish flag, and West Indian *Lantana*. *L. camara* was most likely imported to India before the eighteenth century. It is currently supplied all throughout India. *L. camara* is known by different names in various different languages in India viz, Raimuniya (Hindi), Chaturangi and Vanacehdi (Sanskrit), Arippu and Unnichedi (Tamil), Aripoov, Poochedi, Konginipoo and Nattachedi (Malayalam), Thirei, Samballei and Nongballei (Manipuri), Tantani and Ghaneri (Marathi), Pulikampa (Telugu), Kakke and Natah (Kanada).

The understanding of conventional medicine and medicinal plants, as well as their study of scientific chemical principles, may result in the development of novel, more affordable medications. *Lantana camara* is widely utilized in numerous folk medicinal formulations and is well known for treating a number of ailments. In recent decades, scientists and researchers from all around the world have thoroughly investigated the chemical makeup of the entire *Lantana camara* plant as well as its biological and pharmacological activity. These studies demonstrated the plant's medicinal potential in contemporary medicine and identified it as a promising option for drug discovery. A major source of medications with significant medical value is medicinal plants. These plants' bioactive compounds can be extracted through systematic study to create new pharmaceuticals.

In the past few decades, a great deal of research has been done on the phytochemical makeup of *L. camara*. Essential oils, phenolic compounds, flavonoids, carbohydrates, proteins, alkaloids, glycosides, iridoid glycosides, phenyl ethanoid, oligosaccharides, quinine, saponins, steroids, triterpens, sesquiterpenoides, and tannin are reported to be the main phytochemical groups present in various parts of *L. camara*[5]. These chemicals make *Lantana camara* an effective antifeedant for a variety of pests, including termites, sugarcane pests, rice pests, and others in addition to moths. Additionally, it has larvicidal, anti-cancer, anti-inflammatory, anti-bacterial, anti-fungal, anti-oxidant, and other properties. The infestation of moths on crops is one of the most worrying and destructive issues facing agricultural fields across the world. The order Lepidoptera includes a group of insect species known as moths. Various lepidopteran species exhibit additional traits. The bodies are covered in scales, and there are wings and a proboscis as well. Moths and butterflies have modified scales that have flattened "hairs" and a vast range of colors and patterns[6].

Moths are not butterflies because of their notable differences. Since they are primarily nocturnal, they are active at night. Their body is hairy, and their wings have huge scales. The color of the wings is light brown, gray, or white. Based on their sleeping habits, they can be distinguished readily. Moths repose with their wings outstretched[7].

Table 3: Difference between moth and butterfly.

Sl. No.	Characteristics	Moths	Butterflies
1	Body structure	hairy with larger scales on their wings	fine scales on their wings
2	Wing colouration	pale colours like plain brown, grey or white	bright colours
3	Wing coupling mechanism	frenelum	frenelum absent
4	Pupae	cocoon	Chrysalis
5	Resting posture	rests with spread wings	rests by folding their wings above their backs
6	Time of activity	mostly nocturnal	mostly diurnal

CASE STUDY -

J. E. Smith's *Spodoptera frugiperda* Invasive polyphagous pest Lepidoptera (Noctuidae), also known as the FAW (fall armyworm), is now well-established in Sub-Saharan Africa. A survey of the socioeconomic status of households in Ghana and Zambia was carried out in July 2017. Farmers' perceptions of losses especially attributable to FAW during the most recent crop season were explored through survey questions. Based on the survey's findings, the national average loss of maize was estimated to be 45% in Ghana (range: 22–67%) and 40% in Zambia (range: 25–50%)[8]. This shows how economically a country suffers due to moth pest infestation.

Table 4: Showing Common moth pests

Sl. No.	Common Name	Scientific name	Distribution	Plant they infect	Family
1	Tobacco cut worm or cotton leafworm	*Spodoptera litura*	Asia, India, Oceana	Tobacco, Cotton	Noctuidae
2	Fall Army Worm	*Spodoptera frugiperda*	America, Africa, India (Karnataka)	Maize, Sorghum	Noctuidae
3	Cotton ballworm	*Helicoverpa armygera*	Australia, Europe	Okra	Noctuidae
4	Jute hairy caterpillar	*Spilosoma obliqua*	Pakistan, India, Bhutan, Bangladesh	Jute, Ramie, Sun-Hemp	Erebidae
5	Potato tuber moth	*Phthorimaea operculella*	USA, Africa, Asia, Europe	Potato, Tobacco, Bell Papers, Tomatoes	Gelechiidae
6	Diamond-back moth	*Phthorimaea xylostella*	Europe, Asia, Africa, Australia The Americas,	Cabbage	Plutellidae

How antifeedant activity calculated?

In laboratory two methods are followed nowadays to calculate the antifeedant activity. They are - choice-based antifeedant index and a choice-based antifeedant index.

1. Choice based method -

Whether they ate the treated or untreated disc of food was left up to them. The 24-hour pre-starved larvae were given feeding discs in one Petri dish, one of each treated and control. The measurement of the disc's weight or surface area. Using the following formula from[9], the proportion of antifeedant activity in the choice-based test condition was determined:

Antifeedant index (AI) = **(C –T) × 100 / (C + T)**

Where, C = weight of control disc

T = weight of the treated disc

Real consumption was calculated by the method given by Muthu *et al.* (2015)[10]:

Natural Dryness = (Initial weight of disc - Final weight of disc).

The corrected consumed disc was calculated as follows:

[(Initial weight of disc - Final weight of disc) - Natural Dryness].

This was done for both control and treated discs

2. No-choice method -

Plant extracts' antifeedant properties were investigated using a non-choice bioassay. A food disc that had been dipped in the appropriate concentration of each plant extract was offered. The food disc was stored in a separate petri dish following solvent evaporation at room temperature. A single third-instar pest larva that has been pre-starved should be added to each petri dish. The larva was given twenty-four hours to consume the treated discs. The solvent- and water-sprayed leaf discs were used as the negative and positive controls, respectively. There must be three trials with five duplicates each. The area of the unrated food disc at the end was measured using leaf area, percent antifeedant activity computed using Singh and Pant's formula (1970)[11].

% antifeedant activity = **(C –T) × 100 / (C + T)**

Where, C = weight of control disc in no-choice bioassay

T = weight of treated disc in no-choice bioassay

% larval mortality = Number of dead larvae / Total number of treated larvae X 100

Various Experimental Proofs Showing Antifeedancy of *Lantana Camara*

Case study 1 -*Lantana camara methanolic* crude extract treatment was provided. The feeding deterrency was tested on 3rd, 4th, and 5th instar larvae because in this stage, they are extremely voracious feeder and their consumption is higher as compared to earlier stages. Food consumption in the control group showed an increase; however, it declined in the treated group. At 0.5% concentration, Antifeeding Index (AFI) was 34.82% in 3rd instar larvae which decreased to 14.66% in 4th instar and 4.66% in 5th instar. At 1.0% concentration, AFI was 42.85% in the 3rd instar, which decreased to 20.5% in 4th and 6.08% in the 5th instar. At 2.5% concentration, AFI was 64.28% in the 3rd instar, which decreased to 24.66% in the 4th instar and 21.6% in the 5th instar. At 5.0% concentration, AFI was 72.32% in the 3rd instar, which decreased to 28.66% in the 4th instar and 21.92% in the 5th instar. Thus, the Antifeedant Index increased with increased concentration of methanol extract-fed larvae[12].

Case study 2 - According to Hila *et al.* (2017)[13], the experiment on *Lantana camara* essential oil also produced mild antifeedant effects against the infamous pest *Spodoptera litura* at four dosages, namely 2 mg/ml (52.23%), 4 mg/ml (61.05%), and 8 mg/ml (60.64%). According to their research, one can acquire mild antifeedant activity at 5% concentration[13]**.**

Impact of *Lantana camara* on another pest

Case study 1- Yuan and Hu (2012)[3] investigated the *Lantana camara* chloroform-based leaf extract's repulsive, antifeedant, and toxic properties in *Reticulitermes flavipes* (Isoptera: Rhinotermitidae). *Reticulitermes flavipes* feeding was considerably reduced by all test concentrations in this No-choice experiment when compared to the control in the filter paper No-choice experiment. The antifeedant action more or less depended on concentration.

Case study 2 - An experiment conducted by Saxena (1992)[14] with extracts of *Lantana camara* (Petroleum ether and Methanol) act as strong antifeedants at 5% concentration against *Callosobruchus chinensis* (adzuki bean weevil).

Why Antifeedancy Not Insecticides?

The biggest benefit of antifeedancy is that it prevents the extinction of pests by not eradicating all of them. It prevents eating and is effective in reducing the number of pests in the following generation by preventing development in later life cycle phases, such as the pupal stage or the formation of malformed adults.

In their study, Effects of Toxic Weed *Lantana camara* on the Feeding Behavior and Insecticidal Activity of *Spodoptera litura* Fab. (Lepidoptera: Noctuidae)[15,16], they observed some insecticidal activity at all concentrations, which may have been caused by toxicity brought on by food digestion. At concentrations of 1%, 3%, and 5%, the crude methanolic extract of *Lantana camara* has a mortality rate of 73%, 60%, and 100%, respectively.

In order to maintain ecological equilibrium, there must be some population control. Moths are a nuisance because their larval stages feed voraciously, but otherwise, they are crucial links in the food chain and food web. They are known as entomophily because they are pollinators. The pollination rate will decline without these moths, which will lower plant production and, ultimately, gross productivity. Moths and other species that are either directly or indirectly related to them because of the widespread use of pesticides may go extinct.

An important measure of IPM

The term "Integrated Pest Management" (IPM) refers to a set of practices that include damage control, evaluation, and pest management. IPM attempts to control pest populations below the economic injury level (EIL), which means that during pest management procedures, species diversity should not be restricted.

The point at which treatment should begin to stop the pest population from reaching the injury threshold is known as the action threshold. Antifeedants effectively accomplish the goal in this case. Their ability to feed is decreased, while on the other side, some pest deaths are noted, along with some pupae that are malformed. This aids in keeping insect populations from rising to the point at which they start to cause intolerable damage.

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